

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 14 MAY 2004

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Applicant's or agent's file reference cau.1999.pct.df.e	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB 03/00099	International filing date (day/month/year) 13.01.2003	Priority date (day/month/year) 15.01.2002
International Patent Classification (IPC) or both national classification and IPC G01R31/34		
Applicant UNIVERSITY COURT OF GLASGOW CALEDONIAN UNIVERSITY		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:
 - I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application

Date of submission of the demand 07.08.2003	Date of completion of this report 11.05.2004
Name and mailing address of the international preliminary examining authority:  European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	Authorized Officer Binger, B Telephone No. +49 30 25901-617 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/GB 03/00099**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-24 as originally filed

Claims, Numbers

1-28 received on 30.04.2004 with letter of 30.04.2004

Drawings, Sheets

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

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International application No. PCT/GB 03/00099

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-28
	No: Claims	
Inventive step (IS)	Yes: Claims	1-28
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-28
	No: Claims	

2. Citations and explanations

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB03/00099

- 1) Reference is made to the following documents:

D2: HAESSLER H W ET AL: 'A new measurement technique for the investigation of arcing processes of sliding contacts' PROCEEDINGS OF THE HOLM CONFERENCE ON ELECTRICAL CONTACTS. CHICAGO, OCT. 6 - 9, 1991, NEW YORK, IEEE, US, vol. CONF. 37, 6 October 1991 (1991-10-06), pages 153-155, XP010054555 ISBN: 0-7803-0231-1

D4: US 6452416 B

- 2) The Document **D4**, which is considered to represent the most relevant state of the art, discloses an electric motor monitoring system comprising an antenna from which the subject-matter of claim 1,10 and 15 differs in that the antenna provides means for detecting a radio-frequency signal generated by arcing events **from a brush contact of the electric motor**.

The subject-matter of claim **1,10 and 15** is therefore new (Article 33(2) PCT).

- 3) The problem to be solved by the present invention is to provide an brush contact electric motor monitoring system for the detection of high frequency arcing events.

The solution to this problem proposed in claim 1,10 and 15 of the present application is considered as involving an inventive step (Article 33(3) PCT) because D4 is not disclosing any incentive in the direction of the invention to use an antenna which provides means for detecting a radio-frequency signal generated by arcing events from a brush contact of the electric motor. The further available prior art does not help in the respect either.

The Document **D2**, which could have been considered to represent the most relevant state of the art, discloses a brush contact of an electric motor monitoring system from which the subject-matter of claim 1,10 and 15 differs in that the antenna is not present in D2. The current transformer could not be seen like an antenna, because the current transformer device of D2 has a smaller bandwidth of frequency than the wide bandwidth of the antenna used in the application and the current transformer has a different function than the antenna of the application.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

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- 4) Claims 2-9 are dependent on claim 1, claims 11-14 are dependent on claim 10, claims 16-28 are dependent on claim 15, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

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1 Claims

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3 1. An electric motor monitoring system comprising an
4 antenna, a data sampling means and a data processing
5 means characterised in that the antenna provides
6 means for detecting a radio-frequency signal
7 generated by arcing events from a brush contact of
8 the electric motor, and provides a diagnostic for
9 monitoring the operation of both mechanical and
10 electrical components of the electric motor.

11

12 2. An electric motor monitoring system as claimed in
13 Claim 1 wherein the antenna comprises a means for
14 screening background noise so improving the overall
15 signal to noise ratio of the electric motor
16 monitoring system.

17

18 3. An electric motor monitoring system as claimed in
19 Claim 1 or Claim 2 wherein the antenna further
20 comprises a frequency matching unit such that the
21 frequency matching unit allows the antenna to be
22 frequency tuned so as to optimise its operation with
23 the electric motor.

24

25 4. An electric motor monitoring system as claimed in
26 Claim 4 wherein the frequency matching unit
27 comprises a signal conditioning unit.

28

29 5. An electric motor monitoring system as claimed in
30 any of the preceding Claims wherein the antenna
31 comprises a balanced Faraday screened loop antenna.

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- 1 6. An electric motor monitoring system as claimed in
2 claim 1 to 4 wherein the antenna comprises an
3 unbalanced Faraday screened loop antenna.
4
- 5 7. An electric motor monitoring system as claimed in
6 any of the preceding Claims wherein the antenna
7 comprises an electric field probe or a magnetic
8 field probe.
9
- 10 8. An electric motor monitoring system as claimed in
11 any of the preceding Claims wherein the data
12 sampling means comprises an anti aliasing filter, an
13 analogue to digital converter and a high speed PCI
14 card such the data sampling means allows the high
15 frequency signal, over a predetermined length of
16 time, to be captured.
17
- 18 9. An electric motor monitoring system as claimed in
19 Claim 8 wherein the data processing means further
20 comprises a computer processor capable of
21 manipulating and storing the captured data.
22
- 23 10. An antenna for measuring high frequency radio
24 frequency signals associated with arcing events from
25 a brush contact in an electric motor, the antenna
26 comprising a loop and a loop screen, wherein the
27 loop screen shields the loop from background noise
28 thus improving the signal to noise ratio of the
29 signal detected by the antenna.
30
- 31 11. An antenna as claimed in Claim 10 wherein the loop
32 screen physically covers all but a small detection
33 section of the loop.

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- 1
- 2 12. An antenna as claimed in Claim 10 or Claim 11
- 3 wherein the antenna further comprises a frequency
- 4 matching unit such that the frequency matching unit
- 5 allows the antenna to be frequency tuned so as to
- 6 optimise the antenna's operation with the electric
- 7 motor.
- 8
- 9 13. An antenna as claimed in Claim 12 wherein the
- 10 frequency matching unit comprises a signal
- 11 conditioning unit.
- 12
- 13 14. An antenna as claimed in any of Claims 10 to 13
- 14 wherein the loop comprises a conductor and a
- 15 screened coaxial cable such that the conductor is
- 16 turned back on itself so as to form one or more
- 17 turns while the end of the conductor cable is
- 18 attached to the screen of the coaxial cable.
- 19
- 20 15. A diagnostic method for monitoring the operation of
- 21 both mechanical and electrical components associated
- 22 with an electric motor, the method comprising the
- 23 steps of:
- 24 i) Detecting high frequency radio frequency
- 25 signals associated with arcing events from a brush
- 26 contact within the electric motor;
- 27 ii) Sampling the high frequency signal over a
- 28 predetermined length of time;
- 29 iii) Processing the sampled data so as to provide
- 30 information regarding the mechanical and electrical
- 31 components of the electric motor.
- 32

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- 1 16. A diagnostic method according to Claim 15 wherein
2 the method provides a means for associating the
3 frequency of the high frequency signal to individual
4 components of the electric motor.
5
- 6 17. A diagnostic method according to Claim 15 or Claim
7 16 wherein the detection of the high frequency
8 signals employs a non-intrusive antenna.
9
- 10 18. A diagnostic method according to any of Claims 15 to
11 17 wherein the sampling provides a means for
12 monitoring frequency modulation and amplitude
13 modulation within the high frequency signals.
14
- 15 19. A diagnostic method according to any of Claims 15 to
16 18 wherein the processing of the sampled data
17 comprises the application of Fast Fourier
18 Transformations so as to convert the sampled data to
19 interpretable frequency spectra.
20
- 21 20. A diagnostic method according to any of Claims 15 to
22 18 wherein the processing of the sampled data
23 comprises the application of Digital Signal
24 Processing techniques to the sampled data so as to
25 convert the sampled data to interpretable frequency
26 spectra.
27
- 28 21. A diagnostic method according to Claim 20 wherein
29 the Digital Signal Processing techniques comprise
30 Wavelet Analysis.
31
32
33

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- 1 22. A diagnostic method according to any of Claims 19 to
2 21 wherein the interpretable frequency spectra
3 comprise frequency features that can be directly
4 associated with particular diagnostics of the
5 mechanical or electrical components of the electric
6 motor.
7
- 8 23. A diagnostic method according to any of Claims 19 to
9 22 wherein the interpretable frequency spectra
10 comprise frequency features that can be directly
11 associated with particular mechanical or electrical
12 faults of the electric motor.
13
- 14 24. A diagnostic method according to any of Claims 15 to
15 18 wherein the processing of the sampled data
16 comprises calculating an average width of the high
17 frequency signals, above a predetermined level, over
18 a number of arcing events.
19
- 20 25. A diagnostic method according to any of Claims 15 to
21 18 wherein the processing of the sampled data
22 comprises calculating an average height of the high
23 frequency signals over a number of arcing events.
24
- 25 26. A diagnostic method according to any of Claims 15 to
26 18 wherein the processing of the sampled data
27 comprises calculating an average ratio of the width
28 and height of the high frequency signals over a
29 number of arcing events.
30
- 31 27. A diagnostic method according to any of Claims 15 to
32 26 wherein the method comprises a step of self-
33 calibration of the diagnostic method.

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- 1
2 28. A diagnostic method according to Claim 27 wherein
3 the self-calibration of the diagnostic method
4 comprises a current measuring technique including
5 the sub-steps of:
6 i) Measuring the torque on the electric motor by
7 employing the non-intrusive antenna;
8 ii) Measuring directly the current in the electric
9 motor so as to enable the torque on the electric
10 motor to be calculated;
11 iii) Taking the difference between the two methods
12 for obtaining the value of the torque on the
13 electric motor so providing a compensation factor;
14 and
15 iv) Adding the compensation factor to the non-
16 intrusive antenna method for measuring the torque on
17 the electric motor.